

GIS AS A PRIORITIZATION AND PLANNING TOOL IN ABANDONED MINE RECLAMATION

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ABSTRACT

The Utah Abandoned Mine Reclamation Program has developed a new GIS model for selecting reclamation project areas. The selection process utilizes three main factors that would influence the potential hazard for mining areas. These factors include known mining activity or mineral resource occurrence areas, the population density in proximity to the mining areas and the potential access to the mining areas.

Mine closure priorities should be ranked according to the degree to which the public is exposed to the dangers associated with abandoned mines. The first step in ranking mines for reclamation is to know where they are or where they are likely to be based on potential mineral resource locations. Known mines and the density of those mines received a higher ranking in the model than potential mining areas or mineral resources. The data sets used in the mining component include Computerized Resource Inventory Base (CRIB), gilsonite veins, phosphate deposit areas, locatable mineral occurrences, historic mining district and un-patented mining claims.

The second ranking criteria we use to prioritize abandoned mine closures is the mine's proximity to population centers and the density of the population area. We assumed that mines located near densely populated areas receive greater visitation than mines located far from population centers. The population component of the model uses the census data from 2000.

The third major component of the ranking model is access to the mining areas. The easier a mine is to get to, the more likely people are to visit it. Thus a mine's proximity to a high density of roads significantly contributes to its hazard potential. A roads data set was used to determine the potential access to a mining area. The mining activity, population, and access components were combined to determine which abandoned mines pose the greatest potential risk to the public. The model is then used to generate a map of all areas above a certain hazard-rating threshold. The composite score for each of these areas determines its rank. Thus using GIS, the Utah's AMRP is able to focus abandoned mine reclamation efforts in those areas which pose the greatest threat to public safety.

WHY WE CREATED THE GIS MODEL

In order for the Utah Abandoned Mine Reclamation Program (UAMRP) to achieve primacy under Surface Mining Control and Reclamation Act (SMCRA) it had to have an approved plan outlining its policies and procedures for implementing the act. One significant requirement of the plan was a section detailing how abandoned mine sites would be ranked and selected for reclamation.

The approach the UAMRP took in 1982 looked at the “badness” of a mine site (and its priority for reclamation) as a function of the number and type of problems at the site and the likelihood that people would encounter them. This in turn was a function of the population near the site and the accessibility of the mine to that population (as inferred from the distance, degree and type of road development). Mines would be scored numerical values based on their site features, proximity to people, and accessibility, and ranked by their scores.

When the plan was written in 1982, the UAMRP fully expected the process to be automated. The approach anticipated a GIS, but the available GIS software at the time was rudimentary and cumbersome. GIS-type operations, such as scoring the population within a specified radius of a site, were done manually (by placing a template over a map and consulting census tables). Besides being crude and slow, this necessitated breaking data types into coarse categories or ranges. Nuances in the data were lost and the scoring became a “point in time” snapshot that was not easily updated as conditions changed.

The UAMRP ranking system depended on field inventory data for its scoring. It was originally conceived as working from a data pool with complete or nearly complete statewide field inventory data. In actual practice, the UAMRP could not complete a statewide inventory in a meaningful timeframe (the working estimate is that there are 20,000 abandoned mine openings in the state). The UAMRP proceeded with reclamation as it continued its field inventory effort. Construction projects were selected from the pool of available field data, but since the field inventory generally advanced only a year or two ahead of the construction, the choice of areas to inventory was becoming the *de facto* selection of construction projects.

By the late 1990s it became increasingly clear that the UAMRP project ranking and selection process needed refinement. The underlying philosophical assumptions of risk being a function of features, population, and accessibility were still considered sound, but there needed to be a more systematic application of the ranking and selection principles to the selection of field inventory areas. This required a suitable body of data from non-field sources to work with. Fortunately, advancements in GIS over the years had made such data available and had provided an automated system in which to analyze them conveniently.

By the mid to late 1990s, most of the coal work had been completed and more and more non-coal projects were being targeted. The basic nature of non-coal is that it is more appropriate to rank aggregations—treat groups of mines or regions as ranking unit rather than individual mine openings

THE CONCEPTUAL FORMULATION OF THE GIS MODEL

How the model developed. What we thought we’d want in the model. What we ended up with in terms of available data.

We began formulating a conceptual GIS model to rank and prioritize abandoned mine site areas for reclamation by creating a list of all the spatial datasets we could envision that would give us an indication as to where abandoned mines exist and which of those mines pose the greatest threat to public safety. The following are examples of what we came up with:

Where mines exist:

- CRIB/UMOS
- Mining claim locations
- Mining district locations
- USGS map adit and shaft symbols
- Geologic map (favorable host rock/veins/alteration zones)

Factors increasing public safety hazard of mine site:

- Accessibility (Roads, ATV trails, Hiking trails, etc.)
- Proximity to population centers
- Proximity to recreation areas (State Parks, National Parks, National Monuments and National Recreation Areas, etc)
- Hunting/Sportsman visitation
- Proximity to Tourist destinations
- Use by OHV recreationalists

The next step was to determine what if any data existed as statewide digital data sets. In Utah we have a state agency Automated Geographic Reference Center (AGRC) that is dedicated to storing and maintaining a vast array of statewide data sets. They were our most valuable resource. But by contacting numerous other state and federal agencies we were able to collect some potentially useful data sets as well as to get a feel for what datasets may be coming available over the next few years. The biggest limiting factor in determining which data was useful was whether the data set was available statewide. For example the USFS has digitized all adit and shaft symbols for USGS 7.5 min quad maps containing Forest Service Lands. If available statewide it would likely be some of the most useful data we have as to the locations of abandoned mines, however because the data does not exist for the entire state we were unable to incorporate it into the GIS ranking model.

Once we determined what datasets were available we looked at the data's attributes and began to determine which attribute would provide information for our model. For example the roads dataset contains attribute information detailing the road surface type as well as number of lanes. These attributes give us a clearer picture of the functional mobility they provide beyond just whether a road is or is not present.

CONCEPTUAL GIS MODEL EXPLAINED

The modeling and ranking process looks at three main factors that would influence the potential hazard for mining areas. These factors include known mining activity or mineral resource occurrence areas, the population density in proximity to the mining areas and the potential access to the mining areas.

Mine closure priorities should be ranked in a way that reflects how much exposure to the danger the public is getting. The first step in ranking mines for reclamation is to know where they are or where they are likely to be based on potential mineral resource locations. Known mines and the density of those mines received a higher ranking in the model than potential mining areas or mineral resources. The data sets used in the mining component include Computerized Resource Inventory Base

(CRIB), gilsonite veins, phosphate deposit areas, locatable mineral occurrences, historic mining district and un-patented mining claims.

The second ranking criteria we use to prioritize abandoned mine closures is the mine's proximity to population centers and the density of the population area. We assumed that mines located near densely populated areas receive more visitations than mines located far from population centers. The population component of the model uses the census data from 2000.

The third major component of the ranking model is access to the mining areas. The easier a mine is to get to, the more likely people are to visit it. Thus a mine's proximity to a high density of roads significantly contributes to its hazard potential. A roads data set was used to determine the potential access to a mining area.

The mining activity, population, and access components were combined to determine which abandoned mines pose the greatest potential risk to the public. The model is then used to generate a map of all areas above a certain hazard-rating threshold. The composite score for each of these areas determines its rank. Thus using GIS, the Utah AMRP is able to focus abandoned mine reclamation efforts in those areas which pose the greatest threat to public safety.

TECHNICAL IMPLEMENTATION OF THE CONCEPTUAL GIS MODEL

The geographic datasets were processed using Environmental System Research Institute's (ESRI) Arc/Info software including the Grid extension. The processing of each dataset was programmed in ESRI's Arc Macro Language (AML). By using AML's to process the datasets, attribute values could be easily changed to see how the output datasets varied with different attribute values.

Three main groups of data were used for the model, the access component, which used two roads coverages, the people component consisting of the 2000 census data, and the mines component consisting of a variety of mining datasets. All datasets were converted to grids with a quarter mile grid cell size. Weighted values were assigned to the various attribute components and in the case of the roads and census data, densities were calculated using focalsum calculations. The grids were then merged to form a final composite coverage. Within the final dataset, areas were ranked to define critical areas for AML mitigation.

ADAPTABILITY OF THE GIS RANKING PROCESS

Future

GIS is helping us to concentrate our efforts and resources in those areas where they can do the most good. The datasets produced can be used to represent the portion of the state in which abandoned mine reclamation has been completed. The model also indicates the portion of the state that we have left to investigate on the ground. GIS will help us maximize our limited funding by streamlining the process of prioritizing and planning our future work in these areas.